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AERONAUTICAL AND SPACE

SPACE SOLID-FUEL ENGINES

Moscow NOVOYE V ZHIZNI, NAUKE, TEKHNIKE, SERIYA "KOSMONAVTIKA, ASTRONOMIYA":
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/Text/ ANNOTATION

The subject of this pamphlet is the creation and utilization of solid-fuel engines for space purposes. The authors discuss several types of these engines, as well as the possible prospects for their use in cosmonautics.

This pamphlet is intended for all people who are interested in contemporary problems of space technology.

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NON-NUCLEAR ENERGY

UDC 621.472

FOCUSING HELIOSTATS IN SOLAR POWER PLANTS

Tashkent GELIOTEKHNICA in Russian No 2, Mar-Apr 81 (manuscript received 21 Jan 80)
pp 81-83

ZAKHIDOV, R. A. and KLYCHEV, Sh. I., Central Design-Engineering Office for
Scientific Instruments, UzSSR Academy of Sciences

[Abstract] The authors have devised a method of calculating the design of focusing heliostats for solar power plants with a central tower-type receiver and mirror-type concentrators. It is based on the general expression for the illuminance at a point of the receiver and on an evaluation of the integral in this expression in a system of coordinates which moves relative to the basis coordinates. The calculations yield the radius of curvature of any heliostat as a function of the time, day and year. The results indicate that the design of a focusing heliostat, unlike that of a facet-type heliostat, must be optimized for some range of defocusing angles. The calculations have been programmed in ALGOL, with provisions for focusing of facets. A typical heliostat thus designed has an area of $5 \times 5 \text{ mm}^2$ and is located at a distance of 100 m from the receiver surface. References
3 Russian.

[180-2415]

UDC 662.997:534.22

EXPERIMENTAL STUDY OF SOLAR THERMOELECTRIC GENERATOR WITH HEAT PIPE

Tashkent GELIOTEKHNICA in Russian No 2, Mar-Apr 81 (manuscript received 28 May 79)
pp 66-68

AGABAYEV, Ch., KOLOMOYETS, N. V., MARKMAN, M. A., SIMANOVSKIY, L. M., RZHEVSKIY, V.M. and KAMENSKIY, V. T., "Order of Labor's Red Banner" All-Union Scientific Research Institute of Current Sources

[Abstract] A solar thermoelectric generator with a paraboloidal concentrator can be an excellent source of low and medium power for remote and not easily accessible regions of the country with a high mean-annual solar radiation level. A prototype of such a generator was built with a concentrator 1.5 m in diameter, a d.c. thermoreceiver containing water as the heat carrier, and a tubular

thermoelectric module connected at the hot end to the receiver end of a heat pipe. The thermoelectric module operated at 300°C in its hot cavity with a thermal flux of 1200-1300 W, its cold junction being cooled with running water ($70\text{-}80\text{ cm}^3/\text{s}$) at $22\text{-}24^{\circ}\text{C}$. Actually two modules (Bi , $\text{p-Sb}_2/\text{Te}_3$, Bi_2/Te , n-Te_3), each 8 mm high, were tested. On the basis of the experimental data the authors calculated the performance characteristics namely the electric output power and the efficiency as functions of the thermal flux over the 500-1500 W range and of the solar radiation density over the $500\text{-}900\text{ W/m}^2$ range, with a proper correction for the changes in the temperature of the heat carrying water upon movement of the focal spot of the concentrator into the thermoreceiver cavity. An efficiency of 5% appears feasible under optimum operating conditions. With a design optimization such as the minimum number of batteries in the thermoelectric module, an electrical output power of 42.5 W at an efficiency of 3.15% appears feasible. It is furthermore possible to increase the reflection coefficient of the concentrator above $r=0.8$ and to reduce the heat losses in the thermoreceiver. Figures 3; references 2 Russian. [180-2415]

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TESTING OF SOLAR WATER HEATERS

Tashkent GELIOTEKHNIKA in Russian No 2, Mar-Apr 81 (manuscript received 19 Nov 80) pp 52-54

AZIMOV, S. A., KALANDAROV, B. and PIRMATOV, I. I., Physico-Technical Institute imeni S. V. Starodubtsev, UzSSR Academy of Sciences

[Abstract] Testing of solar water heaters in service is difficult because of the nonsteady operating conditions, but yields reliable performance data. The authors tested a solar water heater in service over the 1979-80 period, this heater consisting of a wooden box with a translucent lid blackened by an absorbing plate of the "tube in a sheet" type and sunlight collectors made of single-pane or double-pane glass. These data were used for a comparative performance analysis in terms of heat balance, temperature distribution, and durability. The results indicate that a new solar water heater is better than an old one which has been in service for a long period of time. Figures 3; references 9: 6 Russian, 3 Western. [180-2415]

DESIGN OF SOLAR HEATING SYSTEM FOR 3-STORY RESIDENTIAL BUILDING LOCATED IN TURKMEN SSR

Tashkent GELIOTEKHIKA in Russian No 2, Mar-Apr 81 (manuscript received 30 Jun 80)
pp 38-42

SMIRNOV, S. I. and TORSHIN, A. S., State Scientific Research Institute of Power Engineering imeni G. M. Krzhizhanovskiy

[Abstract] The performance of a solar air and water heating system for a 3-story residential building ($4,000 \text{ m}^3$ living space) in Ashkhabad (Turkmen SSR) was simulated mathematically on the basis of meteorological and consumer data for this city over the 1965-1970 period. The system includes a battery of sunlight collectors, a 2-loop antifreeze-water heat exchanger, a water tank and an air blower. Any deficit of solar heat is filled by two standby energy sources. The system should be designed to match the available solar heat, varying diurnally and seasonally with the winter months being especially critical, to the demand for air and water heating in the house. The results of this analysis indicate that the sunlight collectors should be inclined at a $50 \pm 10^\circ$ angle to the horizontal and their area on a 2100 m^2 large roof surface inclined at 50° should not exceed 1200 m^2 , to avoid overshadowing. The fraction of total heat demand covered by solar energy is an asymptotically increasing function of the water tank capacity and the air heater efficiency. Accordingly, the former need not exceed 50 m^3 and the latter need not exceed 40%. The efficiency of the solar heating system can be 45% with single-pane glass collectors with a nonselective absorbing surface and 55% with double-pane glass collectors with a selective absorbing surface. Figures 3; table 1; references 3: 1 Russian, 2 Western.
[180-2415]

UDC 662.997:537.22(430.1)

SOME RESULTS OF FIELD TESTS PERFORMED ON SUNLIGHT RECEIVER FOR SOLAR GAS TURBINE PLANT

Tashkent GELIOTEKHIKA in Russian No 2, Mar-Apr 81 (manuscript received 4 Dec 80)
pp 32-37

UMAROV, G. Ya. and KHATAMOV, P. U., Physico-Technical Institute imeni S. V. Satrodubtsev, UzSSR Academy of Sciences, ALIMOV, A. K. and DRABKIN, L. M., All-Union Correspondence Institute of Railroad Transportation Engineers

[Abstract] A special sunlight receiver has been developed by the authors for a regenerative solar gas turbine plant. It is combined with a paraboloidal facet-type concentrator 5 m in diameter. The focal spot of this concentrator was initially 150 mm in diameter, but increased with time to a diameter of 250 mm. The mean thermal flux density here is now 600 kW/m^2 . The outside surface of the

receiver is covered with an asbestos layer and an alabaster layer, both 15 mm thick. The air flow rate and the pressure drop across the receiver were measured with precision instruments, the air temperature was measured with a thermoelectric thermometer and the receiver temperature was measured with an array of chromel-alumel thermocouples. On the basis of these data the authors calculated the transfer of thermal power to the heat carrier and the total heat balance in the receiver-concentrator system. The receiver alone has a high efficiency up to 90%, it delivers a thermal output power of 4.179 kW at an 11 kW thermal input power to the concentrator. Since the central section of coils is most effective, it is possible to further improve the receiver performance by eliminating its cylindrical tail section of coils and thus reduce the already low hydrodynamic drag; the bottom of the receiver should then be filled with coils. Figures 4; tables 1; references 4 Russian.
[180-2415]

UDC 662.997:537.22(088.8)

PHOTOCONVERTERS BASED ON BULK PHOTOVOLTAIC EFFECT

Tashkent GELIOTEKHNIKA in Russian No 2, Mar-Apr 81 (manuscript received 21 Sep 80)
pp 22-28

YEVDOKIMOV, V. M. and MILOVANOV, A. F., "Order of Labor's Red Banner" All-Union Scientific Research Institute of Current Sources

[Abstract] A photoconverter is considered which combines a variband layer with a p-n junction on the narrow-band side, regeneration of the photo-emf in the bulk of the variband layer being the basic phenomenon which contributes to the high-quality performance of such a device. An analysis of the photovoltaic effect and the diffusion process in a p-type variable-width band reveals that the current-voltage characteristic of such a photoconverter under high-intensity illumination approaches a rectangular one, ensuring a high efficiency of the device, when the ratio of electron mobility to hole mobility is sufficiently high and the diffusion path is sufficiently long. The bulk photo-emf is in this case comparable with the total change in width of the forbidden band. References 14: 7 Russian, 7 Western.
[180-2415]

THERMODYNAMIC ANALYSIS AND OPTIMIZATION OF CYCLE CHARACTERISTICS OF REGENERATIVE GAS TURBINE CONVERTERS FOR SOLAR POWER PLANTS

Tashkent GELIOTAKHNIKA in Russian No 2, Mar-Apr 81 (manuscript received 15 Oct 80)
pp 11-21

DRABKIN, L. M., All-Union Correspondence Institute of Railroad Transportation Engineers

[Abstract] A regenerative gas turbine converter for solar power plants consists essentially of a concentrator, a sunlight receiver, a gas turbine, a compressor, an electric generator and a recuperator. Starting such a plant from the cold state requires a separate energy source such as a storage battery or, more efficiently, combining the gas turbine-compressor set with a battery of thermoelectric generators. Here both the thermodynamic cycles of the basic plant and the combination plant are analyzed with the aid of the temperature-entropy diagram, whereupon the internal efficiency of the gas turbine plant and the useful power of the concentrator surface are calculated for purposes of optimization. Figures 5; references 6 Russian.
[180-2415]

TEMPERATURE DEPENDENCE OF CHARACTERISTICS OF SILICON-TYPE HIGH-VOLTAGE PHOTO-CONVERTERS UNDER HIGH-INTENSITY RADIATION

Tashkent GELIOTEKHNICA in Russian No 2, Mar-Apr 81 (manuscript received 27 Mar 80)
pp 7-10

BERESTNEV, O. Yu., DORMIDONTOV, A. A., KOROLEV, B. V., KULIKOV, V. F., NOGA, S. A., STREBKOV, D. S. and UNISHKOV, V. A., "Order of Red Labor's Banner" All-Union Scientific Research Institute of Current Sources

[Abstract] An experimental study of planar n^+-p-p^+-Si high-voltage photoconverters with a matrix structure was made, to compare the temperature dependence of the photo-emf at irradiance levels of 0.1 and 750 W/cm² respectively, to determine the variation of the slope of the voltage-temperature curve with increasing irradiance over this 0.1-750 W/cm² range, and to compare the current-voltage characteristics at the temperatures of 300 and 77 K respectively at an irradiance level of 440 W/cm². The measurements were made with an IFP-800 xenon lamp as the source of high-power light pulses, in a heating-cooling chamber with optical quartz-glass windows for the specimens, a chromel-alumel thermocouple and a photoelectric radiation density meter. From the results, assuming that the decrease of the efficiency is determined only by the voltage drop, one can establish the maximum operating temperature. The results also indicate that, as the photo-emf at room temperature increases, the slope of the voltage-temperature curve decreases and the maximum operating temperature increases. Figures 4; tables 1; references 11: 8 Russian, 3 Western.
[180-2415]

SELF-CONTAINED SOLAR POWER PLANT MODEL WITH HETEROPHOTOCELLS AND RADIATION CONCENTRATORS

Tashkent GELIOTEKNIKA in Russian No 2, Mar-Apr 81 (manuscript received 6 Jan 81)
pp 3-6

ALFEROV, Zh. I., ANDREYEV, V. M., ARIPOV, Kh. K., LARIONOV, V. R. and RUMYANTSEV, V.D.,
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Sciences

[Abstract] A model solar power plant with four mirror-type radiation concentrators, four heterophotocells in series, and a sun tracking mechanism was built and tested in Leningrad. The mirrors (diameter 31 cm, focal length 35 cm) were made of brass with a thin chromium coating, to yield an average reflection coefficient of 0.6 at the 633 nm wavelength. The converters were $\text{Al}_x\text{Ga}_{1-x}\text{As}$ heterophotocells with intermediate conversion of radiation, approximately 19-20% efficient with shielding on the contact grid surface. Included in the plant were heat pipes operating as thermal siphons. The tests included measuring the load characteristics of each heterophotocell as well as of the plant, also determining the accuracy and the energy efficiency of sun tracking. The plant performance was found to be satisfactory with air-convective cooling of the heat conduits and with automatic sun tracking. Figures 4; references 3 Russian.
[180-2415]

UDC 621.01:007.52

DESIGN OF PNEUMATIC DRIVES FOR MANIPULATOR

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 2, Feb 81 (manuscript received 14 May 79) pp 156-158

VOROB'YEV, Ye. I., candidate of technical sciences, docent, and KRAVCHENKO, N. F.,
engineer

[Abstract] Pneumatic drives for a manipulator, operating jointly to move a certain load in a given time, can be designed on the basis of the dynamic equations of motion for the manipulator mechanism and the pressure equations of the filling-evacuating cycle for the cylinder cavities. Here the problem is formulated in Lagrange equations of the second kind for a typical 4-link manipulator performing rotation and radial translation with automatic deceleration. Numerical data on the dimensions of cylinders and pistons are given for meeting specific performance requirements in terms of pressures, air flow rate, piston travel distance and time, load holding capacity, and manipulator hand size. The design based on assuming an independent operation of drives is found to be inadequate and interaction between drives must be taken into account. This leads to larger dimensions, to compensate for the effects of the Coriolis force (about 25% of the useful torque) during rotation and for the effects of the centrifugal force during radial return motion (about 30% of the useful force). Figure 1; table 1; references 2 Russian. [186-2415]

UDC 531.8

ANALYZING FORCE ACTION IN GEAR TRANSMISSIONS OF MANIPULATOR DRIVES

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 2, Feb 81 (manuscript received 13 Jun 79) pp 67-71

OVAKIMOV, A. G., doctor of technical sciences, professor

[Abstract] A manipulator is considered which consists of a rack and $N \leq 6$ movable links joined through gears, the terminal link being a tong and its maneuverability determining the $(N+1)$ th degree of freedom of the manipulator. Two schemes of

transmitting rotary motion are incorporated in the MEM-10 SD manipulator: the first scheme of a unary joint with a gear sector rigidly clamped to link A and driven by a pinion with the axle in link A-1, and the second scheme of a paired joint with link B ≥ 2 revolving about two intersecting axes. The torques in these joints are calculated either starting from the torques at the gears in the planetary train or starting from the torques at the shafts of the drive motors. Figures 2; references 4 Russian. [186-2415]

UDC 621.822.7.004.12

EXPERIMENTAL STUDIES PERTAINING TO EFFECTIVENESS OF ULTRASONIC TREATMENT OF BALLS DURING ELEVATORLESS FINISHING PROCESS

Minsk IZVESTIYA AKADEMII NAUK BSSR: SERIYA FIZIKO-TEKHNIЧЕСКИХ НАУК in Russian No 2, Apr-Jun 81 (manuscript received 11 Apr 79) pp 48-51

YASHCHERITSYN, P. I., KISELEV, M. G., LUGOVOY, V. P. and YES'MAN, G. A., Belorussian Polytechnic Institute

[Abstract] The final operations in the manufacture of balls include their surface finishing by rolling and abrading between two horizontal disks. Experimental studies were made to determine the effectiveness of ultrasonic treatment during this finishing process in the case of steel (grade ShKh-15 chromium steel) balls 3.176 mm in diameter, to class I precision according to State Standard GOST 3722-60. A magnetostrictive converter was used for this purpose, mounted on a bracket with a carriage movable vertically along guide tracks and producing flexural vibrations with an amplitude of 3, 6, or 9 μm and corresponding radial vibrations. The necessary static load was applied with weights through a pulley-and-rope mechanism. A paste consisting of 8.5 wt.% chromium oxide + 8.5 wt.% synthetic fatty acids of the C₁₇-C₂₀ fraction + 83 wt.% machine oil was used as the abrasive. The balls were prerinsed in gasoline and placed in the concentric V-groove of the lower disk. The results of roughness measurements with a "Talesurf" instrument and roundness measurements with a "Talerond" instrument indicate how much faster the allowance material is removed and the ball precision is improved with ultrasonic treatment than without it. The results of microhardness measurements indicate that hardening of the ball surface, depending on the load (which was varied from 0.06 to 0.140 kgf/ball) and on the disk velocity (which was varied from 0.25 to 0.75 m/s), is more effective with ultrasonic treatment by increasing the microhardness readings from 900-960 kgf/mm² up to 1180 kgf/mm² within the first 10-15 minutes (A = 9 μm , P = 0.140 kgf/ball, V = 0.5 m/s). Figures 2; table 1; references 2: 1 Russian, 1 Western. [183-2415]

UDC 531.383

PROGRAMMABLE ANGULAR MOTION OF GYROSTAT DURING DETERMINATION OF ITS ORIENTATION WITH AID OF QUATERNIONS

Kiev PRIKLADNAYA MEKhanika in Russian Vol 17, No 5, May 81 (manuscript received 18 Feb 80) pp 113-116

ZAKRZHEVSKIY, A. Ye., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] The problem of programming motion of a guided solid body about the center of mass involves ensuring the stability of such motion. Here the problem is solved in four systems of coordinates: an inertial one, a principal central one fixed to the object, an orbital one, and one moving forward along the orbit, the last three systems having a common origin. The behavior of the object is described by three Euler equations of dynamics, four equations of kinematics, and three equations of motion for one-degree gyroscopes. The problem of devising the control moments which will ensure stability of the programmed motion reduces to closing this system of equations with a control according to a given particular solution. This is done through superposition of the unit vectors in the hypercomplex quaternions on the basis vectors, with the components of the quaternions possibly having to be expressed through direction cosines. Stabilization is best achieved by containing the transients through optimal regulation, which reduces to solution of the Cauchy problem for a system of Riccati matrix equations. Figure 1; references 7 Russian.
[175-2415]

UDC 531.38

INVERSE PROBLEM OF GYROINERTIAL MEASURING SYSTEMS

Kiev PRIKLADNAYA MEKhanika in Russian Vol 17, No 5, May 81 (manuscript received 31 Jul 79) pp 106-112

ZAKHARIN, F. M. and KHARITONOV, M. A., Kiev Higher Military School of Aviation Engineering

[Abstract] The problem of determining the angular velocity and the linear acceleration of a platform from the output signals of gyroinertial instruments is considered from the standpoint of optimal estimation theory. The equations

of motion for each of N instruments of a gyroinertial measuring system on a platform include, in addition to a function of the generalized coordinates of the sensing elements, of the projections of the absolute angular velocity of the platform, and of the apparent acceleration of the origin of coordinates fixed on the platform, also a term which is the vector of random perturbations. The problem of determining the state vector reduces to a standard problem of nonlinear filtration. It is solved specifically for a system of two electrostatic gyroscopes with unbalanced aspherical wheels in nonequirigid gimbals on a movable platform, assuming a small nutation angle. The procedure involves a preliminary estimation of the components (projections) of the apparent acceleration and of the direction cosines of the angular-momentum vectors, then compensation of the drift and preliminary estimation of the matrix of "true" direction cosines, and then smoothing of all these estimates and estimation of the projections of the absolute angular velocity. A numerical solution according to this algorithm reveals that the error of recovery of the sought parameters of platform motion from the output signals of two electrostatic gyroscopes depends on the calibration of the gyroscope parameters. In the typical case of a platform oscillating conically at a frequency of 1 Hz with an amplitude of 0.1 rad, during an acceleration of 20 m/s^2 , the angular velocity of the platform can be recovered with an error not exceeding 10^{-4} s^{-1} when the error compensation step is 0.001 and the relative error of calibration is approximately 1%. References 9: 8 Russian, 1 Western.

[175-2415]

LASER DEVICE FOR PATH-AVERAGE MEASUREMENT OF SULFUR DIOXIDE IN ATMOSPHERIC AIR

Leningrad IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian
Vol 24, No 5, May 81 pp 84-88

[Article by V. A. Kop'yev, V. V. Malakhov, V. I. Filippov and O. B. Cherednichenko,
Moscow Motor Vehicle and Highway Institute]

[Text] A new instrument is developed and a technique worked out for measuring the concentration of SO_2 averaged over a path. The sensitivity of the instrument over a path 1000 m long is equal to $1.2 \cdot 10^{-7}$ mole/m³. An estimate is made of the error of measurement of pollutant concentration.

The increase in concentration of pollutants in the atmosphere due to human activity is currently a popular research topic. The necessity for checking emissions of pollutants into the atmosphere by industrial and transport facilities requires the development of on-the-spot systems for measuring the concentration of pollutants in air.

This paper describes a laser device for path-average measurement of the concentration of sulfur dioxide in the atmosphere. Laser methods of measuring the concentration of gaseous pollutants have a number of advantages over conventional techniques: high immunity to interference, capability for studying large sections of the atmosphere, nearly instantaneous measurement of concentrations, and the possibility of doing measurements in spots that are inaccessible to sample-taking.

The working principle of the described device is based on the method of differential absorption of laser emission in the atmosphere [Ref. 1]. For operation the spectral band from 280 to 305 nm is selected, where sulfur dioxide has a pronounced absorption spectrum [Ref. 2]. We can get the following expression for the path-averaged pollutant concentration:

$$N = \ln \left(\frac{J_{\lambda_1}^0}{J_{\lambda_1}} \right) / [2L \{ (\alpha_{\lambda_1} z_{1,1}) + (\alpha_{\lambda_1} z_{1,2}) \}]^{-1}, \quad (1)$$

where N is concentration of pollutant averaged over the path, $J_{\lambda_1}^0$ and J_{λ_1} are the radiation intensities on wavelength λ_1 before and after traversing the path respectively, α_{λ_1} is the coefficient of absorption of a molecule on wavelength λ_1 ,

and L is the length of the path. Such processing of measurement results eliminates all system parameters, and also the influence of aerosol scattering and absorption of radiation by other gas components.

Three wavelengths were selected for the work-- $\lambda_1 = 298.0$ nm, $\lambda_2 = 299.5$ nm, and $\lambda_3 = 300.1$ nm--corresponding to two adjacent absorption maxima and the minimum located between them. The laser instrument for path-average measurement of sulfur dioxide concentration is diagrammed in Fig. 1. The second harmonic of radiation ($\lambda = 0.53$ μ m) of LTIPCh-8 laser 1 is used for pumping ILZhI-501 dye laser 2 in which the active medium is a solution of Rhodamine-C in purified ethyl alcohol (0.25 mole/ m^3). This laser is capable of tunable emission in a wavelength band of about 0.6 μ m. The radiation frequency of the dye laser is converted to the second harmonic in frequency doubler 3 based on a nonlinear KDP crystal. The laser facility gave radiation pulses of 10 ns duration (recurrence rate 12.5 Hz, width of lasing peak no more than 0.1 nm). The peak power of the emission pulse of the dye laser

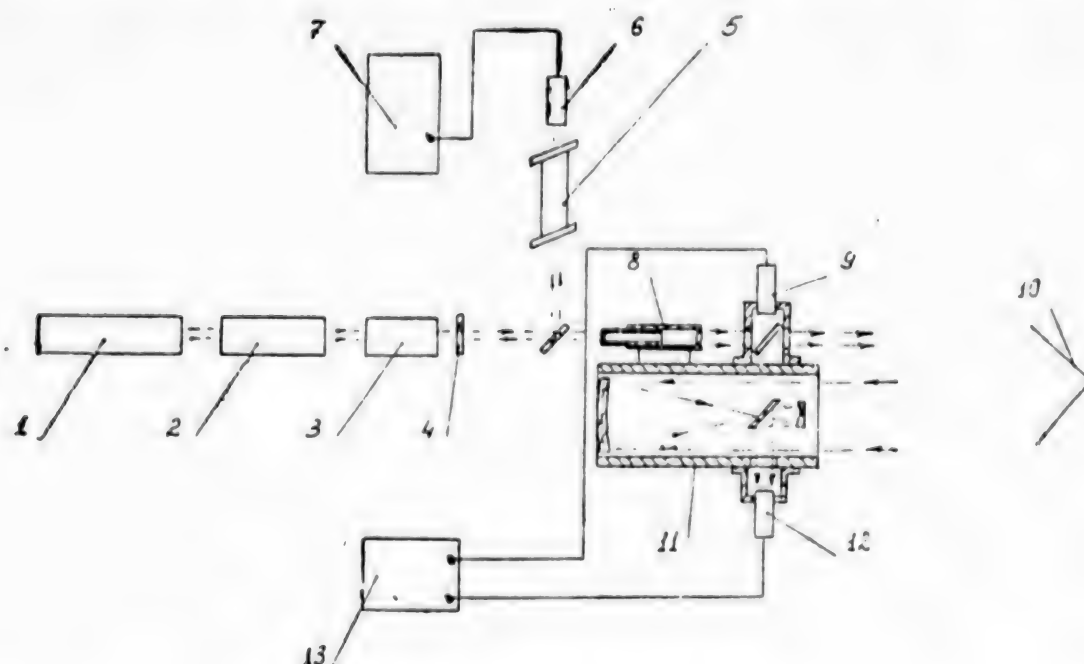


Fig. 1. Block diagram of the device

is 30 kW in the working wavelength band; the coefficient of conversion of radiation to the second harmonic is 5% without focusing and 15% with focusing of the radiation in the nonlinear crystal. The emission wavelength identification unit is intended for exact tuning to sulfur dioxide absorption lines. This unit includes cell 5 filled with sulfur dioxide, FEU-100 photomultiplier 6 and oscilloscope 7. Lens telescope 8 through which the radiation was directed onto the path was used to expand the laser beam and correct the divergence angle of the emission. Part of the radiation was deflected by a quartz plate to photomultiplier 9 and used to shape reference signal J_{λ}^0 . After a round trip over the path (with consideration of reflection from corner reflector 10), the radiation was received by mirror telescope 11 with 100 mm aperture of the reception mirror, and directed to photomultiplier 12. The reference signal and signal J_{λ} from the photomultiplier went to

the input of signal reception and analysis module 13 for preamplification and shaping of the signal of ratio $J_{\lambda}^0/J_{\lambda}$. This module permitted operation in the isolated pulse mode, and also automatic averaging over a series of ten pulses with subsequent digital display of the result. The diagram also shows light filter 4 that cuts out radiation of the fundamental harmonic of the dye laser. Tests have been done on the path-average sulfur dioxide concentration indicator. The SO_2 concentration was measured over Leningrad Prospect in the vicinity of Moscow Motor Vehicle and Highway Institute. The device had a sensitivity of $8 \cdot 10^{-7}$ mole/m³ on a path 150 m long. Averaging was done over 100 pulses on each wavelength. No more than one minute was required to make a measurement of the SO_2 concentration with consideration of the time necessary for tuning the laser. The measurements were made over a period from 10 through 25 August 1979. Operation of the device was verified by using a cell with sulfur dioxide with concentration known from measurements by other methods.

The following factors were taken into consideration in evaluating the error of measurements: fluctuation of intensity of laser radiation upon passage through the turbulent atmosphere, accuracy of measurement of the ratio $J_{\lambda}^0/J_{\lambda}$, by signal measurement and analysis unit 13.

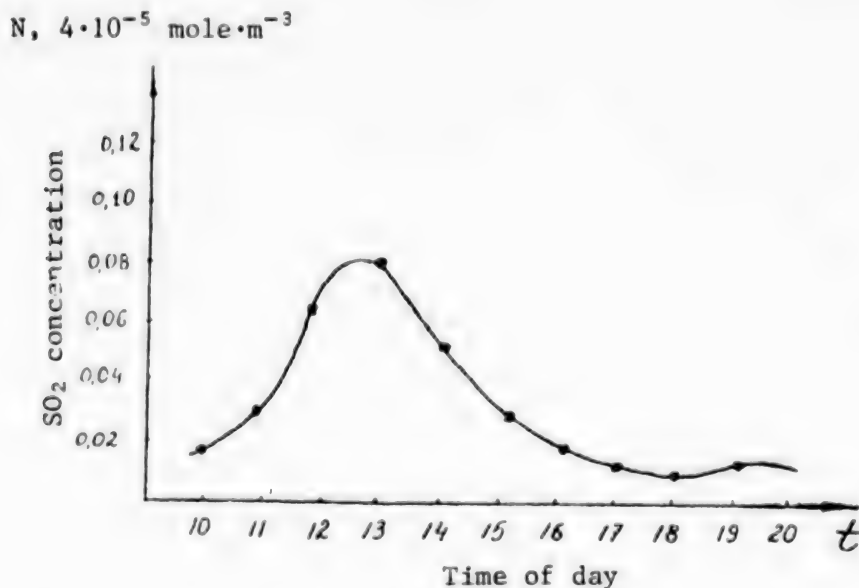


Fig. 2. SO_2 concentration over the path as a function of time of day

In the case of a statistically homogeneous path, use can be made of the results of calculation of the variance of fluctuations of laser beam amplitude for coverage of a path of length L [Ref. 3]. Assuming a structure characteristic $C_n^2 = 10^{-13} \text{ m}^{-2/3}$ in an average strip during daytime in the summer at an altitude of 5 m from the surface with aperture diameter of 5 mm, the error in amplitude measurement can be determined by the relation

$$\Delta \chi = 4 \cdot 10^{-6} L^{1/2}, \quad (2)$$

where L is path length in meters.

The averaging effect of the transmitting and reception aperture for a radius of the reception aperture of 50 mm on a path of 300 m in the case of 100 realizations can be accounted for by a function showing by how many times the relative fluctuations of the total luminous flux through an objective lens of radius R are less than for a point objective [Ref. 4], which in the given instance yields an additional factor of $2 \cdot 10^{-3}$. Consequently the error due to turbulence of the atmosphere for a 300-meter path with consideration of formula (2) is $\Delta\chi = 3 \cdot 10^{-4}$.

The electronic signal reception and analysis module ensured accuracy of measurement of the ratio $J_{\lambda}^0/J_{\lambda}$ equal to 1%. Thus, increasing the length of the path to 1 km to improve the sensitivity of the device to $1.2 \cdot 10^{-7}$ mole/m³ does not cause any appreciable increase in the error associated with fluctuations of the atmosphere when the number of realizations is increased to 1000.

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CSO: 8144/1464

UDC 532.526

BOUNDARY LAYER STRUCTURE AT CONVEX CORNER IN TRANSONIC FLOW WITH FREE STREAM LINE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 257, No 6, 1981
(manuscript received 18 Dec 80) pp 1314-1318

BIYESPEROV, V. N.

[Abstract] A convex corner is considered in a transonic gas stream with free stream line originating at the vertex point. The potential flow outside around the corner is described by the first approximation of the self-similar solution to the Karman equation with the self-similarity exponent $n = 6/5$. The favorable pressure gradient increases infinitely as the vertex is approached from the stream side. The two-dimensional boundary layer and separation problem is formulated and solved in Cartesian coordinates, assuming that the dynamic viscosity and the thermal conductivity of the gas are linear functions of the temperature. The solution process involves collocating the series expansions for the laminar sublayer with the series expansions for the main core of the boundary layer and with the potential outer stream, the latter contributing new terms in those series. The author thanks O. S. Ryzhov for discussing this study. The article was presented by A. A. Dorodnitsyn on 30 Oct 80. References 8: 5 Russian, 3 Western.
[185-2415]

UDC 532.527

ACCELERATED DETACHED FLOW OF INVISCID FLUID AROUND SOLIDS

Moscow DOKLADY AKADEMII NAUK SSSR IN Russian Vol 257, No 6, 1981
(manuscript received 29 May 80) pp 1310-1314

BETYAYEV, S. K.

[Abstract] The author analyzes detached flow of inviscid fluid around bodies, considering that the wake can decrease until the vortex sheet focuses at a point or otherwise stabilizes. The fundamental problem is that of a self-similar flow with a velocity inversely proportional to time, which has already been solved exactly for a flat plate in a symmetric stream. Now the problem is extended to the

case of two spiral vortex sheets originating at the plate edges, where the Zhukovskiy condition must be satisfied. Subsequently the effect of viscosity is discussed, assuming that the coefficient of kinematic viscosity increases from zero at time $t = -\infty$ to infinity at time $t = t_0$ and also taking into account the diffusion of vortices. Finally the problem is generalized to cover any value of the self-similarity exponent n . An exact solution can be obtained when $n \rightarrow 1/2$. The article was presented by academician A. A. Dorodnitsyn on 15 Apr 80. Figures 4; references 4: 2 Russian, 2 Western.
[185-2415]

UDC 621.882.5:534

DAMPING VIBRATIONS OF HYDRODYNAMIC BEARINGS THROUGH ENERGY DISSIPATION

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 2, Feb 81 (manuscript received 27 Mar 80) pp 19-24

RESHETOV, D. N., doctor of technical sciences, professor, and PALOCHKIN, S. V.,
graduate student

[Abstract] Damping the transverse vibrations of hydrodynamic bearings on a rotating shaft through energy dissipation by viscous friction is considered, the analysis being based on the fundamental relations for the circumferential pressure gradient and the instantaneous rate of lubricant flow. The energy dissipation per cycle is calculated for the simple case of an alternating load force acting in a constant direction. The algorithm involves numerical integration, with the aid of a computer, and the use of graphs for a parameter S to which the energy dissipation per cycle in a given bearing-lubricant-shaft system is proportional. Figures 3; references 3 Russian.
[186-2415]

UDC 539.374:678

LIMITING STATE OF FINITE-LENGTH THIN-WALLED SHELLS OF REVOLUTION UNDER CONDITIONS OF CREEP

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 2, Feb 81 (manuscript received 28 Sep 79) pp 7-10

YELSUF'YEV, S. A., candidate of technical sciences, docent

[Abstract] A thin-walled cylindrical shell with rigid covers at both ends is considered which deforms plastically under internal pressure. In order to determine the dependence of its carrying capacity on its length and diameter, the corresponding St. Venant problem is first solved exactly with the volume of material assumed to remain constant. The improper integrals in the resulting transcendental equations are then evaluated approximately, with the circular

shape of the shell assumed to be retained during deformation. The carrying capacity as well as the resistance to fracture are found to increase with decreasing length of a long shell. Figures 2; references 4 Russian. [186-2415]

UDC 539.3

STABILITY OF CYLINDRICAL SHELL MADE OF COMPOSITE MATERIAL WITH VARIOUS POSSIBLE REINFORCEMENT PATTERNS

Kiev PRIKLADNAYA MEKhanika in Russian Vol 17, No 5, May 81 (manuscript received 20 Feb 80) pp 133-136

BABICH, D. V. and KOSHEVOY, I. K., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Cylindrical shells made of composite materials are considered and their stability with various reinforcement patterns under various loads is evaluated theoretically. The analysis involves refined equations of neutral equilibrium for orthotropic shells on hinge supports, taking into account shear in planes normal to the median surface as well as the transverse Poisson effect. On this basis the authors calculated the critical radial and axial pressures acting separately as well as the critical combinations of both pressures acting together. Among the various reinforcement patterns considered, a random pattern on surfaces equidistant from the median surface is found to be most effective in terms of stability under combined radial and axial pressure. Figures 2; table 1; references 4 Russian. [175-2415]

UDC 539.3

FREE VIBRATIONS OF CYLINDRICAL SHELLS WITH LARGE RECTANGULAR HOLES

Kiev PRIKLADNAYA MEKhanika in Russian Vol 17, No 5, May 81 (manuscript received 7 Feb 80) pp 130-133

PAL'CHEVSKIY, A. S., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] An experimental study was made to determine the effect of holes on the free vibrations of cylindrical shells. The tests were performed in a stand consisting of a massive base between two angle brackets rigidly fastened to it, with disks for centering a horizontally mounted shell. Altogether four variants of shells made of the AMg-6M aluminum alloy were tested (radius 200 mm, length 1120 mm, wall thickness 0.5 or 1.0 mm). Some had a 315 mm wide and 720 mm long rectangular hold in the wall, some had two such holes diametrically spaced around the circumference. The shells were reinforced on the outside surface with hoops 40 mm away from the transverse edges of the holes and, in the thinner shells, also with stringers 10 mm away from the longitudinal edges of the holes. The measured fundamental and first five harmonic frequencies are either a little lower

or appreciably lower than those calculated for the corresponding shells without holes on hinge supports. This effect of holes and their reinforcement is explained by transformation of a monolithic shell structure into a structure of panels. Figures 2; tables 3; references 7: 3 Russian, 4 Western.
[175-2415]

UDC 539.3

PERFORMANCE OF ANISOTROPIC MULTILAYER SHELLS UNDER MECHANICAL AND THERMAL LOADS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 5, May 81
(manuscript received 14 Jul 80) pp 127 130

KOKOSHIN, S. S., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] The state of stress of anisotropic multilayer shells is calculated on the basis of the Kirchhoff-Love hypothesis for the entire stack. There is an odd number of layers, all having the same thickness and physico-mechanical properties, in a configuration symmetric with respect to the coordinate surface. The calculations are based on the method of finite elements. A flat triangular plate in a plane state of stress and in flexure serves as the model of such an element. The temperature field can vary arbitrarily over the shell surface, but is assumed to remain constant within each element. The fundamental system of equations is formulated as the steady-state condition for a functional which includes stiffness and elasticity matrices as well as vectors of tangential and flexural strains, also coefficients of thermal expansion. Typical results are shown for a cylindrical shell consisting of three layers, an orthotropic one in the middle between two isotropic ones, with an unreinforced circular hole in the lateral wall symmetrically located between the ends and free of any forces on its contour, in a steady temperature field with the temperature varying linearly across the wall thickness but not varying longitudinally and circumferentially. The maximum compressive stresses around the hole are found in the outer layer. Figures 2; references 3 Russian.
[175-2415]

UDC 539.3

REINFORCEMENT OF CIRCULAR HOLES IN SHELLS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 5, May 81
(manuscript received 11 Feb 80) pp 123-127

SHNERENKO, K. I. and CHEMODANOV, Yu. M., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] A shallow shell with a circular hole is considered, this hole being reinforced with a coaxial elastic flat washer whose thickness and stiffness vary as functions of the angular coordinate in a polar system with the origin at the

center of the hole. The equations describing the state of stress according to Timoshenko with correction for shear are solved for isotropic and orthotropic shell materials on the basis of the classical Kirchhoff-Love theory. The solution is applied to a more general case of a cylindrical shell under axial and circumferential loads, and specifically to such a shell under internal pressure and a reinforcing washer whose thickness varies cosinusoidally around the circumference of the hole. Calculations reveal that, while the variation of the washer thickness does not significantly affect the distribution and the concentration of stresses around a sufficiently small hole, it does so increasingly as the relative size of the hole (ratio of hole radius to shell radius) increases. Figure 1; references 12: 9 Russian, 3 Western. [175-2415]

UDC 539.3

DESIGN OF CIRCULAR CYLINDRICAL SHELL FOR STRENGTH WITH CURVING OF ITS AXIS TAKEN INTO ACCOUNT

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 5, May 81
(manuscript received 26 Dec 78) pp 83-88

ANTONENKO, E. V., Saratov Higher Military Command School

[Abstract] Structures consisting of one long shell or several shells connected into a long line bend under transverse loads like beams, with a deformation of the cross-sectional contour. Here the ovalization of an originally circular cross section (Karman effect) is attributed to curving of the shell axis under additional axial loads. This effect is taken into account in the design of thin elastic cylindrical shells for strength. The axial strain of an element on the generatrix of the median surface at some distance from the neutral axis is represented as the sum of an axial compressive-tensile strain and curvature of the cross section. On this basis the author calculated the potential energy per unit length under a longitudinally distributed non-self-balanced symmetric load plus internal pressure, assuming no shear in the median surface and no circumferential elongation. Application of the Euler variational principle yields an infinite system of interlinked differential equations with variable coefficients and with the curvature of the shell axis expressed as $\varphi(x) = \frac{EI}{M(x)}$ (where x is the longitudinal coordinate). This system can be solved by the method of successive approximations and, in the case of pure flexure, reduces to a single equation. Calculations for the most vulnerable sections of smooth shells with the Poisson ratio $\nu = 0.3$ reveal that the equivalent stress is maximum at the inside fiber at the point where the axial stresses are additive and the circumferential stress is maximum. In short shells $\bar{l} = \frac{L}{R} \sqrt{\frac{S}{R}} < 0.4$ this equivalent stress is equal to the maximum principal axial stress. In longer shells up to $\bar{l} \approx 3$ this equivalent stress can be 2-3 times higher than the axial stress calculated without curving of the axis. In still longer shells $\bar{l} > 3$ the equivalent stress decreases again, owing to a weakening influence of the boundary constraints at the ends. Accordingly, curving of the shell axis must be taken into account in the design of shells with the dimensions $\bar{l} > 0.6$ and $\frac{R}{S} \geq 0.6E/\sigma_{1, \max}^{10}$ (L - length, R - radius, σ_1 - principal axial stress). Figures 3; references 7 Russian. [175-2415]

PROPAGATION OF SMALL PERTURBATIONS ALONG COAXIAL CYLINDRICAL SHELLS WITH FLUID FILLER

Kiev PRIKLADNAYA MEKhanika in Russian Vol 17, No 5, May 81
(manuscript received 18 Dec 79) pp 77-82

PAVLOVSKIY, V. S., Institute of Mechanics, UkSSR Academy of Sciences, Kiev, and
OMETSINSKAYA, Ye. B., Kiev branch, Odessa Institute of Electrical Engineering
of Communications

[Abstract] Two infinitely long coaxial elastic cylindrical shells of different thicknesses are considered with an ideal compressible fluid filling the gap between them. The motion of the fluid due to small perturbations is described by a velocity potential which satisfies the Laplace equation, with boundary condition of impermeability at both walls. This condition and the appropriate generalized equations of dynamics describe the motion of the shells, i.e., the propagation of perturbations along them. An analysis of a harmonic wave of small perturbations propagating through both shells and the fluid leads to a transcendental frequency equation, for which dispersion curves for its first two roots are obtained. The results of these calculations are compared with those for dry shells, and the phase velocities are found to be lower than when calculated according to the classical theory. The results are also compatible with physical concepts, inasmuch as the Kirchhoff-Love hypotheses restrict the strains of elastically deformed shells and would yield values for the frequencies which are too high. Figures 2; references 7 Russian.
[175-2415]

UDC 624.074.4:539.384.4

NONLINEAR DEFORMATION AND STABILITY OF CYLINDRICAL SHELLS UNDER NONAXISYMMETRIC PRESSURE ACCORDING TO ANALYSIS BY METHOD OF FINITE ELEMENTS

Kiev PRIKLADNAYA MEKhanika in Russian Vol 17, No 5, May 81
(manuscript received 16 Nov 78) pp 71-76

KABANOV, V. V. and ZHELEZNOV, L. P., Novosibirsk

[Abstract] A circular cylindrical shell is considered under an arbitrary load. The displacement field due to nonlinear deformation is calculated by the method of finite elements relative to displacements. The shell is subdivided into m segments along the generatrix and n segments around the circumference. Expressions are derived for the displacements and the potential energy of each of these $m \times n$ rectangular elements, whereupon the total potential energy of the shell is varied according to the principle of possible displacements. The energy criterion of stability and the variational principle it yields are subsequently used for determining the critical load on such a shell. A typical illustrative example

is a freely supported circular cylindrical shell under an external pressure nonuniformly distributed around the circumference. Calculations were made with the aid of a BESM-6 high-speed computer for a thin shell ($R/h = 100$) subdivided into $m = 10^L$ $n = 16$ elements (L - length, R - radius, h - wall thickness). Figures 3; References 5: 3 Russian, 2 Western.
[175-2415]

UDC 539.3

FREE VIBRATIONS OF CYLINDRICAL SHELLS REINFORCED BY ELASTIC HOOPS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 5, May 81
(manuscript received 5 May 80) pp 66-70

KOSMODAMIANSKIY, A. S. and TATARINOVA, O. P., Donetsk State University

[Abstract] Free vibrations of circular cylindrical shells with reinforcing elastic hoops are analyzed by the Rayleigh-Ritz energy method. Such a shell is represented as a discrete-continuous structure consisting of a smooth shell subject to torques and an array of generally irregular hoops with variable elastic properties. First the potential energy and the kinetic energy of the entire system are calculated in the form of integrals, for given boundary constraints and assuming periodicity, whereupon the sum of both is differentiated with respect to the amplitudes of harmonic vibrations. The condition of maximum total energy, i. e., zero derivative yields the frequency equation and solution of the latter yields the spectrum of natural frequencies. Numerical solutions to the problem have been obtained with the aid of a YeS-1022 computer for thin cylindrical shells freely supported, hinge supported, or rigidly clamped at the end with several identical elastic reinforcing hoops. The results indicate that the lowest fundamental frequencies in this case correspond to elastic shell surfaces with $m = 2, 3$ wavelengths around the circumference (with $m = 5, 6$ wavelengths around the circumference in the case of shells without reinforcement). The results also indicate the effect of discrete spacing of hoops on the fundamental natural frequency as well as the dependence of the latter on the location of a reinforcing hoop along the inside surface. Figures 3; references 7: 6 Russian, 1 Western.
[175-2415]

UDC 539.3

HYDROELASTIC STABILITY OF COAXIAL CYLINDRICAL SHELLS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 5, May 81
(manuscript received 9 Jan 79) pp 57-65

KOZAROV, M. and MLADENOV, K., Higher Institute of Architecture and Structural Engineering, Sofia, Bulgaria

[Abstract] Two long coaxial cylindrical shells are considered with a fluid flowing through the inner one as well as through the gap between both. The dynamic

behavior of such shells, particularly their hydro(aero)elastic stability is analyzed on the basis of the linear theory. The more general case is that of two elastic shells. Special cases are those of a perfectly rigid inner shell or outer shell. The equations of motion for the more general case, assuming an ideal fluid and a potential flow, can be solved analytically by reduction to a system of algebraic equations with six unknown constants and subsequently to a system of frequency equations which yield the critical fluid velocity as well as the relations between the frequencies of shell vibrations and the velocity of the fluid. A simpler method of solution is based on the Vlasov differential equations for thin shells, according to the membrane theory, disregarding the inertia of the median surfaces. The determinant of the frequency equations yields a fourth-degree complete algebraic equation, with four coefficients and one free term, which is conveniently solved by numerical methods with the aid of a computer for any combination of shell parameters. Typical results are shown pertaining to the critical fluid velocities for either of the two shells. Figures 5; references 6: 4 Russian, 1 Polish, 1 Western.
[175-2415]

UDC 539.3

EFFECT OF ACOUSTIC AMBIENT MEDIUM ON BUCKLINE OF STRUCTURES UNDER HEAVY LOAD

Kiev PRIKLADNAYA MEKhanika in Russian Vol 17, No 5, May 81
(manuscript received 16 Nov 78) pp 33-37

KORNEV, V. M., Institute of Hydrodynamics, and STEPANENKO, M. V., Institute of Mining, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] Buckling of thin-walled structures such as beams, plates and shells under a dynamic load in an acoustic ambient medium is analyzed, for the purpose of correlating experimental data with theoretical data based on idealization in vacuum. The authors studied the longitudinally periodic deformation of a structure supported on hinges at the ends and loaded in axial compression by a force much larger than the Euler critical force. The modes of normal movement are described by a single resolving differential equation with the deflection of the structure and the pressure of the ambient fluid as variables. Perturbation in the fluid are described by the wave equation for the velocity potential. The general method of asymptotic solution, referred to the extreme case of ambient vacuum, is applied to three examples. The first is a plate on hinge supports at the ends under cylindrical flexure. The second is an infinitely long cylindrical shell under transverse compression. The third is a cylindrical shell of finite length under either axial compression or dynamic hydrostatic pressure. Figure 1; references 5 Russian.
[175-2415]

THREE-DIMENSIONAL PROBLEMS IN THEORY OF ELASTICITY FOR MULTILAYER CYLINDERS WITH NONCANONICAL INTERFACES

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 5, May 81
(manuscript received 26 Jun 80) pp 19-26

NEMISH, Yu. N., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Three-dimensional boundary-value problems in the theory of elasticity are formulated for multilayer thick-walled noncircular cylinders with noncanonical interlayer boundaries. An exact general solution to these problems cannot be obtained by separation of variables, it is therefore sought in the form of series and obtained in any desirable approximation. Accordingly, the problem is reduced to a recurrent sequence of corresponding boundary-value problems for circular cylindrical surfaces. Cylinders with orthogonal noncanonical interlayer boundaries are considered first, with either no forces or only normal axial forces acting on the bases, or with the bases rigidly clamped. Cylinders with nonorthogonal noncanonical interlayer boundaries are considered next, with the geometry of these boundaries as well as of the lateral cylinder surface varying either around the circumference only or along the generatrix only. These two special cases include cylinders with correspondingly corrugated surfaces. Figures 3; references 11: 9 Russian, 1 Polish, 1 Western.
[175-2415]

REFINED THEORY OF PIEZOCERAMIC SHELLS

Yerevan IZVESTIYA AKADEMII NUAK ARMYANSKOY SSR: MEKHANIKA in Russian Vol 34, No 1, Jan-Feb 81 (manuscript received 31 Mar 80) pp 55-64

ROGACHEVA, N. N., Institute of Problems in Mechanics, USSR Academy of Sciences

[Abstract] An arbitrary thin piezoceramic shell is considered with uniform electric polarization normal to the median surface. The three-dimensional boundary-value problem of electroelasticity and electrostatics for such a shell, together with the equations of motion in a triorthogonal system of coordinates whose axes coincide with lines of principal curvatures of the median surface, is reduced to a two-dimensional problem through approximate integration for the appropriate boundary conditions at the shell faces in terms of mechanical stresses and electric potentials. The complete system for this theory includes, besides the equations of equilibrium and electroelasticity, also relations for the electric field intensity vector and the electric induction vector. With an asymptotic representation of the state of stress and strain, this theory is the most precise one within the limitations of the Kirchhoff-Love hypotheses, a still higher precision requiring that transverse shear as well as other second-order effects be taken into account. A typical design and performance evaluation of a piezoceramic

shell involves solving the mechanical problem first, according to this theory, and then calculating the electrical quantities by algebraic operations from the already determined forces and moments. The author thanks A. L. Gol'denveyzer for the continuous interest in this study and the helpful consultations.

References 4 Russian.

[184-2415]

UDC 539.3:534

EXCITATION OF PRESTRESSED CYLINDER

Moscow PRIKLADNAYA MATEMATIKA I MEKhanika in Russian Vol 45, No 2, Mar-Apr 81
(manuscript received 23 Apr 80) pp 384-389

KALINCHUK, V. V. and POLYAKOVA, I. B., Rostov-na-Donu

[Abstract] Excitation of an infinitely long uniformly prestressed circular cylinder by elastic banding vibrating on its surface is analyzed in accordance with the linearized theory of propagation of elastic waves. The material of the cylinder is assumed to be compressible and initially isotropic, with an arbitrary elasticity potential. The corresponding axisymmetric boundary-value problem is reduced to a system of integral equations, or one such equation, depending on the conditions of contact between cylinder and banding. An analysis of the numerical solution for the specific case of radially vibrating banding reveals the influence of initial stresses on the wave propagation process in the cylinder. Their influence is found to increase with their magnitude. The authors thank V. A. Babeshko for the interest in this study and the helpful discussion of its results. Figures 5; references 5 Russian.

[181-2415]

EXPRESSION FOR IMAGINARY PARTS OF EIGENVALUES TO PROBLEM OF SHELL VIBRATION IN COMPRESSIBLE MEDIUM

Moscow PRIKLADNAYA MATEMATIKA I MEKhanika in Russian Vol 45, No 2, Mar-Apr 81
(manuscript received 28 Jan 80) pp 380-383

SIMONOV, I. V., Moscow

[Abstract] The problem of forced vibrations of a shell in a fluid is considered, the resonance peaks here being limited by damping and being inversely proportional to the imaginary parts of the eigenvalues. For the purpose of estimating the dissipative effects, the eigenvalue-problem is solved for a thin elastic closed shell in a boundless ideal compressible fluid under an internal load. The singularities of the solutions are exponentially increasing functions of the space coordinate, obtainable from the Neumann solution to the Helmholtz problem.

Application of Green's theorem leads to an integral expression for the energy balance and insertion here of the particular solution to the original problem yields an exact expression for the imaginary parts of the eigenvalues in terms of energy integrals. An approximation for practical use is possible by referring to an incompressible fluid. The author thanks A. L. Gol'denveyzer and V. B. Lidskiy for discussing this study. References 6 Russian.

[181-2415]

UDC 539.311

THEORY OF STABILITY FOR THIN-WALLED CYLINDRICAL SHELLS UNDER EXTERNAL PRESSURE

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 45, No 2, Mar-Apr 81
(manuscript received 20 Feb 79) pp 376-380

GUZ', A. N., Kiev

[Abstract] A linearized two-dimensional theory of stability is constructed for thin-walled circular cylindrical shells under a uniform external pressure. The stability problem for such a shell made of an elastic and isotropic material is formulated in accordance with the Kirchhoff-Love hypothesis, with the external pressure regarded as a "tracking" load on the median surface. From the fundamental differential equations in displacements the author derives the characteristic equation from which the critical pressure can be calculated in accordance with the engineering theory of shells. The results for the specific case of a hinge-supported shell indicate that, while the classical solution for a dead load is also applicable here, corrections based on a comparison with experimental data pertaining to hydrostatic loading of such a shell are necessary. References 12 Russian.

[181-2415]

UDC 539.375

SELF-ADJOINT THREE-DIMENSIONAL PROBLEM OF SUPERSONIC WEDGING EFFECT ON ELASTIC BODY

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 45, No 2, Mar-Apr 81
(manuscript received 7 Feb 80) pp 348-355

BORZYKH, A. A., Kursk

[Abstract] An infinitesimally thin knife edge with a constant sweepback angle is considered moving at a constant supersonic velocity through an elastic body. The three-dimensional problem of supersonic cleavage of an elastic solid body, relevant to electron-beam and laser-beam methods of cutting, is treated as a problem in the dynamical theory of elasticity. The corresponding equations in

displacements, formulated taking into account the geometrical symmetry and the generalized Hooke's law for a sagittal knife edge remaining inside the characteristic cone, are linearly transformed and reduced to a self-adjoint Dirichlet boundary-value problem in the theory of analytic functions of two complex variables. A relation between the variables reduces it further to a problem in one complex variable. The general method of solution is then demonstrated on one important limiting case, namely where Mach fronts produce a stress singularity near the edge of subsonic dislocational fracture. The author thanks G. P. Cherepanov for his comments. Figures 3; references 9 Russian.
[181-2415]

UDC 539.3

NATURAL VIBRATIONS OF COMPOUND SHELL STRUCTURE

Kiev DOKLADY AKADEMII NAUK UDRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 5, May 81 (manuscript received 20 Oct 80)
pp 50-53

KOSMODAMIANSKIY, A. S., corresponding member, UkSSR Academy of Sciences, and
TATARINOVA, O. P.

[Abstract] A thin circular cylindrical shell is reinforced with N stiffener hoops on the inside and joined at each end to an annular disk clamped around its inside contour. The frequency spectrum of natural vibrations of this compound structure is calculated by the energy method. Accordingly, the kinetic energy and the potential energy of each component are determined separately. With the displacements expressed as products of space harmonics and time harmonics, the condition of maximum total energy yields a system of linear algebraic equations from which a third-degree frequency equation for such a shell is obtained. The frequency spectrum is found to be similar to that of a plain reinforced cylindrical shell without end plates, the corresponding frequencies lying somewhere below those of a rigidly clamped shell and above those of a freely supported shell. References 4 Russian.
[182-2415]

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